RESTRICTED CIRCULATION

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Agricultural Memorandum No 645

Average monthly heat losses from glasshouses by day and night for selected sites - D Forsdyke.

MAFF Bulletin No 115, Commercial Glasshouses, gives in an appendix tables of estimated monthly degree days below a series of base temperatures and a method is quoted for estimating the heating requirement of an area of glass by assuming a mean value for the thermal transmission of the glass - the 'U' value.

It is well known that the rate of heat loss from a glasshouse depends on the wind speed as well as the temperature lift. Since wind speeds are generally higher during the day than at night, when the lowest temperatures generally occur, a different 'U' value should be used to calculate the day time losses compared with those at night. In fact Morris quotes the relationship:

$$U = 0.75 + .05\ W$$

where U is the thermal transmission in BTU/sq ft/hr/degree F temperature lift, and W is the wind speed in mph.

Computer printouts of frequency tables of temperature versus wind speed were obtained for 6 stations having the required hourly values for various periods stored in a computer data bank. The temperatures were in steps of 1°C and wind speeds were divided into 10 ranges. The appropriate 'U' value for each of the 10 wind speed ranges was calculated from Morris's relationship and, using a desk computer, the average monthly heat loss per sq ft of glass was calculated assuming 6 different internal temperatures. This was done separately for day and night periods and the assumed daylength for each month is shown in the tables. Despite base temperatures being given in °C the heat losses have been given in the probably more familiar English Units rather than the more consistent SI units.

These figures since they allow explicitly for the effect of wind speed and its diurnal variation as well as the diurnal variation of temperature should enable better estimates of average heat requirements especially when different day and night temperatures are required. It is interesting to note that when allowance is made for the relative day/night length and for a given base temperature that the rate of heat loss is roughly the same by day and night. In other words lower night temperatures are compensated for by higher wind speeds during the day.

REFERENCES

MAFF Bulletin No 115 (1964) - Commercial Glasshouses.
Morris L G (1961) - The Heating and Ventilation of Greenhouses - "Atti del Convegne Internazionale per Haddifesa delle Colture o degli Allevevamenti dalle Avversita Atmosferische - Torino 22-23 Ottobre 1961".

Any comments or suggestions on this paper should be referred to the author.

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August 1974

Month	Daylight Hours GMT	London Airport (1949-1971) 1000's BTU/sq ft											
		Base Temperature °C											
		22		19		16		13		10		7	
		Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Jan	09-16	10.0	20.2	8.2	16.8	6.5	13.5	4.7	10.1	2.9	6.8	1.5	3.9
Feb	08-17	11.4	16.1	9.4	13.4	7.3	10.8	5.2	8.1	3.3	5.5	1.7	3.2
Mar	07-18	13.2	13.8	10.5	11.3	7.7	8.9	5.1	6.5	2.8	4.1	1.2	2.1
Apr	06-19	12.3	9.8	9.1	7.8	6.1	5.9	3.4	3.9	1.4	2.1	0.4	0.8
May	05-20	10.0	6.0	6.7	4.5	3.7	3.0	1.5	1.6	0.4	0.6	0.1	0.1
Jun	04-20	6.6	3.7	3.7	2.4	1.6	1.3	0.5	0.4	0.1	0.1	0	.01
Jul	05-20	4.7	3.5	2.2	2.1	0.7	0.8	0.1	0.2	.01	.01	0	0
Aug	06-19	4.3	4.6	1.9	2.7	0.5	1.1	0.1	0.2	.01	.02	0	0
Sep	06-18	5.2	6.0	2.9	3.9	1.2	2.0	0.3	0.7	0.1	0.2	.01	.02
Oct	07-17	7.3	9.5	4.9	7.0	2.8	4.6	1.2	2.4	0.4	1.0	0.1	0.3
Nov	08-16	9.2	15.0	7.3	12.0	5.4	9.1	3.6	6.1	1.9	3.5	0.7	1.5
Dec	09-16	9.0	18.8	7.3	15.5	5.6	12.2	3.9	8.9	2.3	5.7	1.1	3.1
Total		103.2	127.0	74.1	99.4	49.1	73.2	29.6	49.1	15.6	29.6	6.8	15.0

Month	Daylight Hours GMT	Thorney Island 1959-1971 1000's BTU/sq ft											
		Base Temperature °C											
		22		19		16		13		10		7	
		Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Jan	09-16	9.7	19.9	8.0	16.5	6.3	13.2	4.5	9.8	2.8	6.5	1.4	3.5
Feb	08-17	10.7	15.2	8.7	12.7	6.8	10.1	4.9	7.6	3.0	5.1	1.5	2.8
Mar	07-18	13.1	13.5	10.5	11.1	7.8	8.7	5.2	6.3	2.7	3.9	1.1	1.8
Apr	06-19	12.3	9.4	9.3	7.5	6.3	5.6	3.5	3.7	1.3	1.9	0.3	0.6
May	05-20	10.5	6.1	7.1	4.6	4.0	3.1	1.5	1.6	0.3	0.5	.05	0.1
Jun	04-20	7.2	3.8	4.0	2.5	1.5	1.3	0.3	0.4	0.1	0.1	.01	.01
Jul	05-20	5.1	3.6	2.3	2.2	0.6	0.8	0.1	0.2	.01	.01	0	0
Aug	06-19	5.5	4.6	2.8	2.7	0.8	1.0	0.1	0.2	.02	.02	0	0
Sep	06-18	5.2	5.7	2.8	3.7	0.9	1.8	0.2	0.6	.05	0.1	.01	.01
Oct	07-17	6.6	9.1	4.3	6.5	2.2	4.0	0.8	1.9	0.2	0.7	.05	0.2
Nov	08-16	8.4	14.8	6.5	11.7	4.6	8.6	2.7	5.6	1.2	3.0	0.4	1.3
Dec	09-16	9.6	19.1	7.8	15.7	6.0	12.3	4.2	8.9	2.5	5.7	1.2	3.1
Total		103.9	124.8	74.1	97.4	47.8	70.5	28.0	46.8	14.2	27.5	6.0	13.4

Month	Daylight Hours GMT	Plymouth (Mountbatten) (1949-1971) 1000's BTU/sq ft											
		Base Temperature °C											
		22		19		16		13		10		7	
		Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Jan	09-16	9.6	19.4	7.7	15.7	5.8	12.0	3.8	8.3	2.0	4.8	0.9	2.3
Feb	08-17	11.4	15.7	9.2	12.8	7.0	10.0	4.8	7.1	2.6	4.3	1.2	2.2
Mar	07-18	13.8	13.7	10.8	11.1	7.9	8.5	5.0	5.8	2.4	3.2	0.8	1.3
Apr	06-19	13.1	9.5	9.9	7.5	6.7	5.5	3.6	3.5	1.2	1.5	0.2	0.4
May	05-20	11.8	6.4	8.1	4.8	4.7	3.2	1.7	1.6	0.3	0.4	.03	.05
Jun	04-20	8.5	4.0	5.0	2.7	2.0	1.4	0.3	0.3	.04	.04	0	0
Jul	05-20	6.5	3.9	3.2	2.4	0.8	0.9	0.1	0.1	.01	.01	0	0
Aug	06-19	5.7	4.9	2.7	2.9	0.6	1.1	.06	0.2	.01	.02	0	0
Sep	06-18	6.3	6.1	3.5	3.9	1.2	1.8	0.2	0.4	.04	0.1	0	.01
Oct	07-17	7.4	9.4	4.9	6.7	2.5	4.0	0.8	1.6	0.2	0.5	.05	0.1
Nov	08-16	8.5	14.1	6.4	10.9	4.3	7.7	2.3	4.5	0.9	2.1	0.2	0.7
Dec	09-16	8.9	18.2	7.0	14.4	5.1	10.7	3.2	7.0	1.5	3.7	0.6	1.7
Total		111.5	125.3	78.4	95.8	48.6	66.8	25.9	40.4	11.2	20.7	4.0	8.8

Month	Daylight Hours GMT	Cardiff (Rhoose)(1957-1971) 1000's BTU/ sq ft											
		Base Temperature °C											
		22		19		16		13		10		7	
		Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Jan	09-16	10.9	22.0	9.0	18.3	7.1	14.7	5.1	11.0	3.2	7.3	1.6	4.0
Feb	08-17	12.5	17.5	10.3	14.6	8.0	11.7	5.8	8.8	3.6	5.9	1.8	3.3
Mar	07-18	15.6	15.5	12.5	12.8	9.3	10.1	6.2	7.4	3.4	4.7	1.3	2.3
Apr	06-19	14.1	10.7	10.9	8.6	7.6	6.5	4.5	4.4	1.9	2.4	0.5	0.8
May	05-20	12.3	6.9	8.6	5.3	5.1	3.6	2.1	2.0	0.5	0.7	0.07	0.1
Jun	04-20	8.8	4.4	5.3	3.0	2.2	1.7	0.5	0.5	0.1	0.1	.01	.01
Jul	05-20	7.0	4.5	3.6	2.9	1.0	1.3	0.1	0.3	.01	.04	0	0
Aug	06-19	6.3	5.7	3.2	3.6	0.8	1.6	0.1	0.4	.01	.06	0	.01
Sep	06-18	6.9	6.9	4.1	4.6	1.6	2.4	0.4	0.8	0.1	0.2	.02	.03
Oct	07-17	8.2	10.5	5.7	7.7	3.2	4.9	1.2	2.3	0.3	0.8	0.1	0.2
Nov	08-16	9.5	16.4	7.5	13.1	5.4	9.8	3.4	6.6	1.6	3.6	0.5	1.5
Dec	09-16	10.2	21.0	8.3	17.3	6.4	13.6	4.5	9.9	2.7	6.2	1.3	3.3
Total		122.3	142.0	89.0	111.8	57.7	81.9	33.9	54.4	17.4	32.0	7.2	15.5